

EFFECT OF DIET ON FECES COMPOSITION AND THE IMPLICATIONS ON ENVIRONMENTAL QUALITY¹

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Primary Audience: Nutritionists, Environmental Quality Regulators, Egg Producers

SUMMARY

Three experiments were conducted to determine the effects on fecal nitrogen (FN) and phosphorus (FP) levels by varying dietary nitrogen and phosphorus. Hens received diets containing either 15.5, 12.7, or 12.7% protein plus 150 g of added methionine/ton. Their feces were analyzed for total nitrogen. On a dry basis, FN averaged 6.07, 5.47, or 5.12%, respectively for the 15.5, 12.8, or 12.8% protein plus 150 g of added methionine/ton diets. Another group of hens received diets containing 3.0% calcium with either 0.45, 0.55, or 0.65% total phosphorus, and their feces were analyzed. On a dry weight basis, FP was 1.89, 2.19, and 2.78%, respectively.

In a second series of diets, FP from a control diet (3.6% calcium and 0.45% phosphorus) was compared to the effects of diets with either 3.0 or 4.2% calcium and either 0.50, 1.00, or 1.50% phosphorus. FP for the control diet was 1.65, 1.86, 3.76, or 5.37% for the 3.0% calcium series and 2.09, 3.53, or 5.57% for the 4.2% calcium series with phosphorus of 0.50, 1.00, or 1.50%, respectively.

These data indicate that nitrogen and phosphorus levels in the feces can be reduced and environmental quality protected by feeding regimes.

Key words: Environmental quality, feces composition, manure nitrogen, manure phosphorus

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DESCRIPTION OF PROBLEM

Many poultry layer operations are having increased difficulty in obtaining or are being denied conditional use permits for building complexes due to "inadequate" manure management and utilization plans. Many existing operations are experiencing increased cost of manure utilization due to regulations relating to nitrogen or phosphorus levels in surface or ground water [1, 2].

The opportunity exists to reduce fecal nitrogen (FN) and fecal phosphorus (FP) by dietary management. Reports indicate that FN can be lowered by reducing excess dietary protein [3] and FP by reducing dietary levels and balancing calcium and phosphorus ratios [4]. These procedures reduce the amount of land required for manure spreading and decrease the risk of surface and ground water pollution.

This study was conducted to confirm the reduction of FN levels by lowering dietary protein and also to evaluate the possibility of lowering FN by better balancing the amino acid profile of the diet. FP levels were examined at different calcium levels.

MATERIALS AND METHODS

EXPERIMENT 1

One hundred and five Hy-Line W36 hens at 42 wk of age were randomly assigned to one of three dietary regimes (Table 1). Diets were 15.5% crude protein, 12.7% crude protein, and 12.7% crude protein plus 150 mg of methionine/ton of feed. Seven replications of five birds/replicate received each dietary regime. Methionine (150 mg/ton of finished feed) was added to the 12.7% crude protein diet to enhance the amino acid balance and test the theory that an amino acid balance would further enhance nitrogen (crude protein) utilization.

Manure samples were taken after hens had been consuming diets for at least two weeks. Samples were collected on plastic trays for a 3-day period from two groups of five hens/treatment. Samples were thoroughly mixed and two subsamples were taken as unpaired samples to the State of Florida Livestock Waste Testing Laboratory [5] for nitrogen analysis.

TABLE 1. Composition of diets (Experiments 1 and 2)^A

INGREDIENT	EXPERIMENT 1			EXPERIMENT 2		
	Normal Protein	Low Protein	Low Protein + Methionine	Phosphorus Content (%)		
				0.45	0.55	0.65
Yellow corn	67.11	71.96	71.96	75.63	75.38	75.13
Soybean meal (48.5% protein)	22.25	15.65	15.65	15.40	15.42	15.45
Limestone	7.16	7.18	7.18	7.31	6.99	6.67
Dicalcium phosphate (18.5 P + 21% Ca)	2.32	2.36	2.36	0.77	1.31	1.86
Microingredients	0.58	0.58	0.58	0.50	0.50	0.50
Salt	0.44	0.44	0.44		0.33	0.33
DL-Methionine	0.14		0.02	0.06	0.06	0.06
Sand		1.87	1.85			
CALCULATED ANALYSIS (%)						
Protein	15.46	12.70	12.70	12.70	13.88	13.87
Calcium	3.3	3.3	3.3	3.01	3.01	3.01
Phosphorus	0.74	0.74	0.74	0.45	0.55	0.65
Methionine	0.40	0.22	0.24	0.29	0.29	0.29
Lysine	0.85	0.66	0.66	0.67	0.67	0.67

^AIngredients and analysis expressed as percent of total diet

EXPERIMENT 2

Three diets (Table 1) containing 3% calcium and either 0.45, 0.55, or 0.65% total phosphorus were fed to five replications of five Hy-Line W36 hens at 44 wk of age. Sampling procedures were the same as outlined for Experiment 1. The same laboratory analyzed samples for phosphorus.

EXPERIMENT 3

A series of seven diets (Table 2) was fed to 140 randomly assigned 52-wk old Hy-Line W36 hens. Treatments consisted of an industry control diet (3.6% Ca and 0.45% P) and diets of either 3.0 or 4.2% calcium with 0.50, 1.00, or 1.50% phosphorus fed at each level of calcium. Each treatment was fed to four replicates of five birds each. Manure samples were collected as in Experiment 1 and analyzed by a commercial laboratory [6] for phosphorus content.

RESULTS AND DISCUSSION**EXPERIMENT 1: FECAL NITROGEN**

As Table 3 shows, the reduction of dietary crude protein from 15.5 to 12.7% (18.07%) was accompanied by a reduction in FN from 6.07 to 5.47% (9.89%). Egg size and production declined significantly. These findings are in general agreement with Summers [3], who found a reduction in FN of 21.8% (5.30 vs. 4.35%) when dietary protein was reduced

13.3% (15 vs. 13%). The additions of dietary methionine resulted in a FN reduction of 6.4% (5.47 vs. 5.12%), resulting in an overall FN reduction of 15.65% (6.07 vs. 5.12%). The addition of methionine restored egg size and production to control levels.

These results indicate that dietary crude protein reduction is a major factor in influencing FN levels but may negatively affect production. The amino acid profile of the diet is likewise important, and in this experiment restored production and egg size. In areas where application of poultry manure to land is regulated by manure nitrogen content and areas where ground or surface water contamination is a problem, dietary protein level and especially amino acid balance should be given strong consideration.

EXPERIMENT 2: FECAL PHOSPHORUS (ONE CALCIUM LEVEL)

Reduction of total dietary phosphorus from 0.65 to 0.55% (15.4%) resulted in a FP reduction from 2.78 to 2.19% (21.23%) as Table 4 shows. Reducing total dietary phosphorus from 0.55 to 0.45% (18.19%) resulted in an FP reduction from 2.19 to 1.89% (13.7%). The overall effect of reducing dietary phosphorus from 0.65 to 0.45% (calcium held constant at 3.00%) was a reduction in manure phosphorus from 2.78 to 1.89%. Dietary phosphorus was reduced 30.77% (0.65 vs. 0.45%) and FP was reduced 32.02% (2.78 vs. 1.89).

TABLE 2. Composition of diets (Experiment 3)

INGREDIENT	%						
Yellow corn	73.64	75.51	74.25	72.99	72.00	70.74	69.48
Soybean meal (48.5% protein)	15.76	15.41	15.53	15.64	15.73	15.85	15.96
Limestone	8.85	7.15	5.58	4.00	10.28	8.71	7.14
Dicalcium phosphate (18.5% P + 21% Ca)	0.79	1.04	3.76	6.48	1.09	3.80	6.52
Microingredients	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Salt	0.38	0.33	0.33	0.32	0.33	0.33	0.32
DL-Methionine	0.08	0.06	0.06	0.06	0.06	0.07	0.07
CALCULATED ANALYSIS							
Protein	13.88	13.88	13.83	13.79	13.75	13.70	13.66
Calcium	3.60	3.01	3.01	3.01	4.21	4.21	4.21
Phosphorus	0.45	0.50	1.00	1.50	0.50	1.00	1.50
Methionine	0.30	0.29	0.29	0.30	0.30	0.30	0.30
Lysine	0.68	0.67	0.67	0.67	0.67	0.67	0.67

TABLE 3. Fecal nitrogen from hens fed three different diets (Experiment 1)

Dietary protein (%)	15.50	12.80	12.8 + meth ^A
Fecal nitrogen (%)	6.07	5.47	5.12

^AMethionine was added at 150 g/ton.

TABLE 4. Fecal phosphorus from hens fed diets with three different levels of phosphorus (Experiment 2)

Dietary phosphorus (%)	0.65	0.55	0.45
Fecal phosphorus (%)	2.78	2.19	1.89

A reduction in total dietary phosphorus accompanied an almost identical level of reduction in FP. This finding indicates that any excess dietary phosphorus is excreted and that the phosphorus requirement of the hen under conditions of this experiment was not significantly greater than 0.45%. Egg production and eggshell quality were not negatively affected at the lower phosphorus level. Phosphorus is an expensive feed ingredient and a manure pollutant. Thus, phosphorus levels in the diet should be maintained at the lowest possible levels.

EXPERIMENT 3: FECAL PHOSPHORUS (MULTIPLE CALCIUM LEVELS)

Increasing the dietary calcium level from 3.0 to 4.2% (140%) had no effect on fecal phosphorus levels. Average fecal phosphorus from hens fed diets with 3.0% calcium was 3.66% and 3.73% from hens fed diets with 4.2% calcium (Table 5). Increasing dietary

phosphorus within calcium level did produce results similar to those found in Experiment 2. In general, increasing dietary phosphorus was accompanied by an almost parallel increase in FP (see also Experiment 2).

Manure from hens fed the commercial diet (3.6% Ca and 0.45% TP) had a phosphorus content of 1.65%. This finding was 88.7% of the FP level from hens fed the 3.00 calcium and 0.50% phosphorus diet. This result compares to a dietary phosphorus level of 90.0%. Again, dietary phosphorus reduction was accompanied by a comparable reduction in FP.

These experiments confirm the results of Experiment 2. Excess dietary phosphorus is passed through into the manure. Dietary total phosphorus in excess of 0.45% is largely passed into the manure. The calcium level appears to have little effect on FP levels. Egg production and eggshell quality were unaffected by the phosphorus or calcium level.

TABLE 5. Fecal phosphorus from hens fed diets with different levels of calcium and phosphorus (Experiment 3)

Dietary Calcium (%)	Dietary Phosphorus (%)	Fecal Phosphorus (%)
3.6	0.45	1.65
3.0	0.50	1.86
3.0	1.00	3.76
3.0	1.50	5.37
4.2	0.50	2.09
4.2	1.00	3.53
4.2	4.50	5.57

CONCLUSIONS AND APPLICATIONS

1. Controlling the manure nutrient profile by dietary manipulation is possible and desirable, especially in areas where land and water pollution problems are possible from land application of poultry manure.
 2. FN levels may be reduced by reducing excess dietary crude protein. Reducing crude protein below essential amino acid levels will negatively affect production and egg size.
 3. FN levels may be further reduced without negatively affecting production by balancing the dietary amino acid profile.
 4. FP levels may be reduced by feeding dietary total phosphorus levels no greater than 0.45 to 0.50%. Dietary phosphorus levels higher than this are accompanied by increases in FP in a linear fashion.
 5. Dietary calcium levels have little effect on FP levels.
 6. Considerable feed cost savings can be realized by managing phosphorus levels.
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REFERENCES AND NOTES

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